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Exploring the Role of Desmos in Mathematics Learning: A Quantitative Descriptive Study

Rahman Nul Hakim^{1*}, Martin Suhendra², M. Zainul Arifin³

^{1, 2, 3} Pendidikan Matematika, Universitas Lambung Mangkurat

*Penulis korespondensi: rahmanhakim.rnh@ulm.ac.id

Abstrak

Penelitian ini berupaya untuk menyelidiki fungsi platform Desmos dalam pendidikan matematika melalui metodologi deskriptif kuantitatif. Subjek penelitian berjumlah 32 siswa, dievaluasi berdasarkan tiga dimensi utama: pemahaman konsep, motivasi belajar, dan keterlibatan siswa dalam pembelajaran matematika. Data dikumpulkan melalui angket yang bertujuan untuk menilai tanggapan siswa terhadap keunggulan Desmos dalam memfasilitasi proses pembelajaran. Hasil penelitian menunjukkan bahwa pemanfaatan Desmos berpengaruh positif terhadap ketiga dimensi yang dievaluasi. 50,02% siswa setuju, dan 38,76 persen sangat setuju bahwa Desmos meningkatkan pemahaman konseptual matematika mereka. Mengenai motivasi, 44,4% siswa setuju dan 36,9% sangat setuju bahwa Desmos meningkatkan motivasi mereka untuk belajar matematika. Terkait dengan keterlibatan siswa, 40,64% siswa setuju dan 28,14% sangat setuju bahwa pemanfaatan Desmos meningkatkan partisipasi mereka dalam proses pembelajaran. Studi ini menemukan bahwa Desmos secara signifikan meningkatkan pemahaman konsep, motivasi belajar, dan keterlibatan siswa dalam pendidikan matematika.

Kata Kunci: desmos, pemahaman konsep, motivasi belajar, keterlibatan siswa

Abstract

This study seeks to investigate the function of the Desmos platform in mathematics education via a quantitative descriptive methodology. The study's subjects were 32 students, evaluated on three principal dimensions: conceptual understanding, learning motivation, and student engagement in mathematics education. Data were gathered through a questionnaire aimed at assessing students' impressions of the efficacy of Desmos in facilitating the learning process. The study's results demonstrate that the utilization of Desmos positively influences all three evaluated dimensions. 50.02% of students concurred, and 38.76 percent strongly concurred that Desmos enhances their conceptual understanding of mathematics. Concerning motivation, 44.4% of students concurred and 36.9% strongly concurred that Desmos augments their motivation to study mathematics. In relation to student engagement, 40.64% of students concurred and 28.14% strongly concurred that the utilization of Desmos enhances their participation in the learning process. This study finds that Desmos significantly enhances conceptual understanding, learning motivation, and student involvement in mathematics education.

Keywords: desmos, conceptual understanding, learning motivation, student involvement

INTRODUCTION

The study of mathematics at the senior high school level, especially in the area of combinatorics, frequently encounters difficulties in improving students' conceptual understanding. Poçan, Altay, & Yaşaroğlu, (2023) assert that conventional teaching techniques devoid of interactivity may impede students' comprehension of abstract subjects like combinatorics. Consequently, numerous students find it challenging to conceptualize and implement these principles in practical scenarios. Moreover, students' motivation and involvement in the learning process frequently remain inadequate, resulting in subpar learning results (Ryan & Deci, 2017).

Recent studies on web-based mathematics learning highlight the significant potential of digital tools in enhancing students' conceptual understanding and motivation. For instance, research by Hakim & Andayani (2024) on the use of the WordPress-based educational website, ganapatih.com, revealed highly positive student responses, with a response score of 81.2%. This learning platform employs instructional videos, interactive worksheets, and infographics designed to increase student engagement and facilitate understanding of statistical concepts like mean, median, and mode. These findings underscore the importance of interactive digital tools in creating a supportive and empowering learning environment. Thus, integrating digital tools into mathematics instruction could be an effective strategy for addressing challenges in teaching combinatorics at the senior high school level.

The utilization of digital tools such as Desmos presents considerable promise to resolve these challenges. Through dynamic representation and direct interaction, Desmos facilitates students' comprehension of abstract topics and promotes active engagement in the learning process (Nadifah & Furqan, 2024). Nonetheless, investigations on the application of Desmos to improve students' comprehension, motivation, and engagement in combinatorics at the senior high school level are scarce and require additional examination.

This study seeks to investigate the impact of Desmos on enhancing students' conceptual understanding, motivation, and engagement in combinatorics at the senior high school level. This research offers insights for educators to enhance teaching methods, aids students in comprehending combinatorial concepts more profoundly, and contributes to the literature on digital technology in mathematics education.

Contemporary constructivist theory underscores the significance of interaction between learners and materials in the educational process. Schrader (2015) asserts that constructivist learning is facilitated by interactive digital tools such as Desmos, which allow students to develop comprehension through exploration and direct manipulation. Furthermore, Ryan & Deci (2017) motivation theory posits that engaging technologies might augment students' intrinsic motivation, therefore promoting greater participation and enhancing educational outcomes. Research conducted by Carlos (2024) demonstrates that digital learning tools, including interactive apps and online platforms, significantly enhance student engagement in high school classrooms by increasing motivation and participation through personalized learning experiences. Similarly, a study by Rafiq, Iqbal, & Afzal (2024) on higher education highlights that digital tools such as learning management systems (LMS), interactive simulations, and virtual labs significantly improve academic performance, engagement, and motivation. These tools facilitate a more flexible and accessible learning environment, allowing students to learn at

their own pace and engage more deeply with the material. The integration of these technologies not only promotes critical thinking and collaborative learning but also supports the development of essential 21st-century skills, which are crucial for success in an increasingly digital world

METHODS

This study will employ a quantitative descriptive methodology to investigate the influence of Desmos on mathematics education, particularly focusing on its effects on students' conceptual comprehension, motivation, and engagement in combinatorics learning. The research will involve 32 senior high school students from the X grade at MAN IC Tanah Laut, concentrating on combinatorial concepts within the Merdeka curriculum. Data will be gathered utilizing a standardized questionnaire aimed at evaluating three specific competences, with each competency examined through five closed-ended questions employing a Likert scale.

The gathered data will next be examined by descriptive statistics, encompassing means, frequencies, and percentage to encapsulate students' responses. This investigation will yield insights into the effectiveness of Desmos in enhancing students' mathematical learning experiences.

RESULT AND DISCUSSION

The research findings in this study focus on three key aspects: conceptual understanding, motivation, and student engagement, specifically within the context of combinatorics. These elements are crucial for comprehending and excelling in mathematical problem-solving. Conceptual understanding measures the students' ability to grasp and apply fundamental principles of combinatorics, such as permutations, combinations, and basic counting. Motivation assesses the factors that influence students' drive to engage deeply with the subject, while student engagement evaluates their active participation in learning activities. Each of these aspects plays a significant role in shaping the overall learning experience, and the following sections will delve into the results for each in detail, providing insights for enhancing teaching strategies in combinatorics.

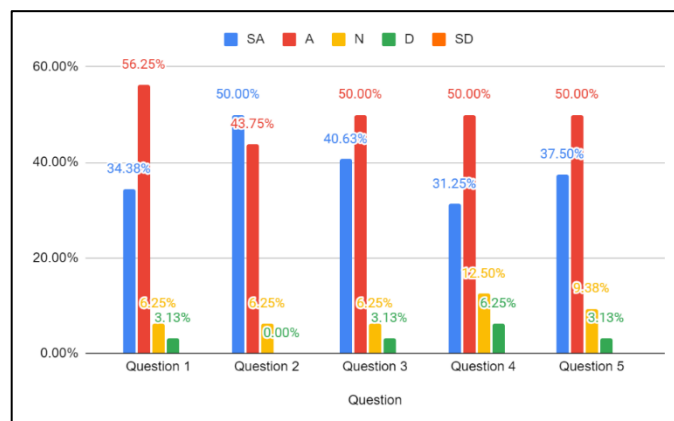


Figure 1. Findings from the Questionnaire Regarding Students' Perspectives on Desmos and Its Impact on Conceptual Understanding

Firstly, Fig 1. illustrates differing degrees of consensus regarding Desmos' influence on conceptual comprehension. In response to Question 1, 56.25% agreed, 34.38% indicated strongly agreed, 6.25% remained neutral, and 3.13% disagreed. In Question 2, 50% agreed, 43.75% strongly agreed, and 6.25% remained neutral. Question 3 had 50% agreement, 40.63% strong agreement, 6.25% neutral responses, and 3.13% disagreement. In response to Question 4, 50% agreed, 31.25% indicated strongly agreed, 12.50% remained neutral, and 6.25% disagreed. Ultimately, Question 5 exhibited 50% agreed, 37.50% strongly agreed, 9.38% neutral, and 3.13% disagreement. The subsequent table displays the five conceptual understanding questions.

Table 1. List of Questionnaire Items Regarding Students' Conceptual Understanding with Desmos in Combinatorics

Number	Question
Question 1	Desmos enhances my comprehension of fundamental combinatorial principles
Question 2	Utilizing Desmos facilitates the computation of comb permutations
Question 3	My confidence in solving combinatorics issues has increased after utilizing Desmos
Question 4	Desmos aids my comprehension of the practical uses of combinatorics in real-world scenarios
Question 5	Desmos augments my capacity to understand and resolve issues pertaining to combinatorics

In comparison to previous studies, the results of the current questionnaire corroborate earlier research indicating that Desmos substantially improves students' conceptual comprehension in mathematics. A study by Chechan, Ampadu, & Pears (2023) revealed that pupils use Desmos demonstrated a considerable enhancement in their mathematics ability relative to those who did not employ the tool. A recent study by Pope (2023) corroborated that platforms such as Desmos promote engagement and assist students in visualizing and comprehending intricate algebraic topics, hence improving both conceptual and procedural fluency. The 2024 research by Madrilejos (2024) further corroborates these observations, emphasizing that Desmos facilitates pupils' development of a profound comprehension and proficiency in equation solving.

Moreover, Previous research corroborate the current findings, indicating that over 90% of students concurred or strongly concurred that Desmos enhanced their learning experience. This consistency indicates that Desmos not only promotes improved conceptual comprehension but also enhances student engagement and confidence across many mathematical subjects, while a minority of students may not perceive it as advantageous based on their learning preferences.

Secondly, Fig. 2 presents the results of a questionnaire assessing students' views on the use of Desmos and its effect on learning motivation. This bar chart illustrates the percentage distribution of respondents' replies to five questions, assessed via a Likert scale.

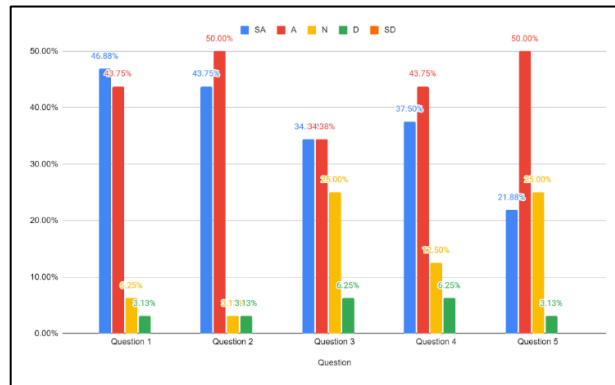


Figure 2. Findings from the Questionnaire Regarding Students' Perspectives on Desmos and Its Impact on Learning Motivation

Desmos, with the greatest percentages recorded in the "Strongly Agree" (SA) and "Agree" (A) categories for nearly all enquiries. Significantly, for questions 2 and 5, the "Agree" group attained 50%, signifying that half of the respondents perceive Desmos as positively influencing their learning motivation. Nonetheless, there exists some variability between the "Neutral" and "Disagree" categories, indicating that a minority of students did not see a substantial effect from utilizing Desmos.

Furthermore, The findings of this study correspond with current literature, like Chen & Huang (2024), which demonstrated that digital tools such as Desmos markedly enhance student motivation and involvement in learning. Chacón-Prado (2023) emphasized the beneficial impact of interactive platforms on improving learning experiences, especially in promoting active engagement and motivation. These studies underscore the increasing significance of technology in education over the previous decade, corroborating the findings of the present research. The five questions used to assess students' perspectives on motivation can be found in Table 2.

Table 2. List of Questionnaire Items Regarding Students Motivation with Desmos in Combinatorics

Number	Question
Question 1	Desmos enhances my enthusiasm for studying math
Question 2	I am more inspired to confront mathematical issues after utilizing Desmos.
Question 3	The utilization of Desmos amplifies my enthusiasm for learning and investigating new mathematical subjects.
Question 4	Desmos aids in maintaining my concentration during mathematics instruction.
Question 5	I am more likely to pursue further information on mathematics after utilizing Desmos.

Thirdly, Figure 3 presents the results of a questionnaire assessing students' views on the utilization of Desmos and its effect on student participation in learning.

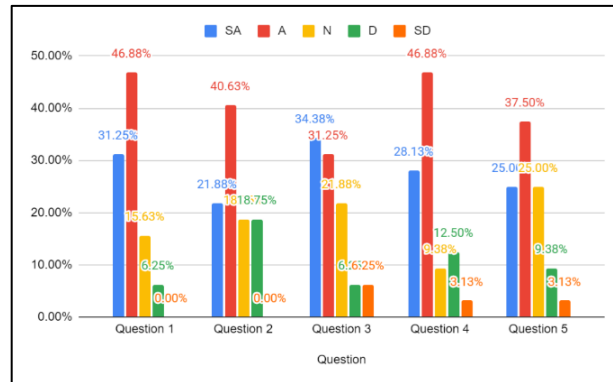


Figure 3. Findings from the Questionnaire Regarding Students' Perspectives on Desmos and Its Impact on Students Engagement

The chart results demonstrate that most students expressed favorable opinions about Desmos's influence on their learning engagement, with significant percentages in the "Strongly Agree" (SA) and "Agree" (A) categories, especially for questions 1 and 4, where "Strongly Agree" attained 46.88%. Nonetheless, there exists substantial variability in the "Neutral" and "Disagree" categories, particularly for questions 2 and 3, indicating that certain students did not entirely perceive an enhancement in involvement through the utilization of Desmos.

Moreover, This study's findings align with prior research by Farmer (2024), which shown that interactive technologies such as Desmos substantially improve student participation in mathematics education. A study by Madawistama, et al., (2024) highlights that mobile learning significantly enhances student engagement and motivation in mathematics education. By providing flexible access to learning materials, mobile applications facilitate independent and personalized learning experiences, enabling students to better understand mathematical concepts. Moreover, the integration of mobile learning strengthens students' confidence and motivation, leading to improved academic performance. These findings align with prior research, which consistently demonstrates a positive relationship between technology integration in classrooms and heightened student involvement and achievement. The five questions used to assess can be found in Table 3.

Table 3. List of Questionnaire Items Regarding Students Engagement with Desmos in Combinatorics

Number	Question
Question 1	My engagement in math's learning activities has increased following the use of Desmos.
Question 2	My engagement in posing inquiries to educators or classmates during arithmetic instruction has increased following the utilization of Desmos.
Question 3	Desmos motivates me to engage in collaborative problem-solving with classmates in mathematics.
Question 4	I find it more conducive to share mathematical concepts and strategies utilizing Desmos.
Question 5	I engage more often in class conversations regarding mathematics after use Desmos.

Furthermore, Table 4 delineates the assessment criteria for conceptual understanding, learning motivation, and engagement. The criteria are categorized

according to value ranges, facilitating the assessment of student achievement in various areas

Table 4. Evaluation Criteria for Conceptual Understanding, Learning Motivation, and Participation

Value Range	Category
$90 < X \leq 100$	Very Good
$80 < X \leq 90$	Good
$70 < X \leq 80$	Adequate
$X \leq 70$	Insufficient

Additionally, Table 5 presents the mean scores for three assessed dimensions: Conceptual Understanding, Motivation, and Student Engagement. The data indicates that the Conceptual Understanding component has the highest average score of 84.9, followed by Motivation with an average of 82.75. Currently, Student Engagement possesses the lowest average score of 76.25. This data offers a comprehensive summary of students' performance regarding conceptual comprehension, motivational levels, and their engagement during the learning process.

Table 5. Mean scores of conceptual understanding, motivation, and student engagement.

Aspect Evaluated	Mean Score
Conceptual Understanding	84.9
Motivation	82.75
Student Engagement	76.25

According to Tables 4 and 5, the results demonstrate that Conceptual Understanding attained an average score of 84.9, categorizing it as Good, since it lies within the range of $80 < X \leq 90$. Likewise, Motivation attained an average score of 82.75, categorizing it within the good range. Conversely, Student Engagement attained a score of 76.25, which lies within the interval of $70 < X \leq 80$, so classifying it as Adequate. In summary, Conceptual Understanding and Motivation are rated as Good, whilst Student Engagement is deemed Adequate.

The study's findings indicate that both conceptual knowledge and motivation are classified as Good, whereas student participation is categorized as Adequate. These findings align with prior studies about the application of interactive technologies such as Desmos in mathematics teaching, which have shown beneficial impacts on student comprehension and motivation. A study by Glaze, Glaze, Moyer-Packenham, & Longhurst (2021) demonstrated that the incorporation of dynamic mathematics software in the educational process markedly improved students' conceptual understanding and motivation relative to conventional techniques. Research by Hidayat & Firmanti (2024) indicated that students utilizing interactive mathematical tools shown increased interest, particularly in difficult subjects like combinatorics.

The diminished student engagement score, classified as Adequate, corresponds with the conclusions of Vali (2023), who contend that although technology can enhance comprehension and motivation, it may not completely engage all students, especially if they are not actively involved in problem-solving

tasks or collaborative learning. This indicates that although Desmos has the capacity to enhance learning results, additional efforts are required to bolster student involvement, including through increased interactive or collaborative activities.

Conversely, research by Di Pietro & Castaño Muñoz (2025) indicates that mere technological integration is inadequate for sustaining elevated engagement levels over time, especially if students do not recognize direct relevance or do not encounter diverse instructional methods. This represents a potential drawback of the current study, since it predominantly concentrated on solo utilization of Desmos, excluding collaborative or inquiry-based learning approaches that may have enhanced engagement scores.

From a personal perspective, the findings of this study underscore that although technological tools like Desmos can significantly enhance conceptual comprehension and boost motivation, sustaining elevated levels of student engagement necessitates more than only the implementation of technology. Active learning tactics, such collaborative problem-solving, peer interaction, or gamified activities, are essential to enhance student involvement and maintain engagement during the learning process.

Future study should investigate a broader range of methodologies in utilizing interactive tools such as Desmos, incorporating tactics that promote both autonomous and cooperative learning to maximize all facets of education conceptual understanding, motivation, and engagement. Furthermore, longitudinal studies are essential to ascertain the enduring effects of these technologies on student outcomes.

CONCLUSION

This study concludes that the utilization of interactive tools such as Desmos in mathematics teaching significantly enhances both Conceptual Understanding and Motivation, with both features categorized as Good. Nonetheless, Student Engagement was classified as Adequate, suggesting that although Desmos improves comprehension and motivation, it may not completely engage students without additional measures to promote active engagement. These findings underscore the necessity of augmenting technology with interactive, collaborative, or inquiry-based learning methodologies to promote deeper engagement. Future initiatives should concentrate on incorporating these tactics to enhance the overall efficacy of digital tools in advancing learning outcomes across all facets.

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